Advanced Communication Systems

ACS-R Receiver
Operating Manual

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Issue 2001

• Advanced Communication Systems •
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ALL ACS PRODUCTS ARE DESIGNED FOR CONTINUOUS COMMERCIAL SERVICE

The ACS R144, R220 and R450 series receivers are high performance commercial grade units designed for the professional. They are engineered to provide maintenance free operation in demanding repeater, links, and base station application.

Circuitry is continued in a 5" (12.75mm) x 7.375" (18.75mm) x 2.5" (6.4mm) aluminum enclosure. Connection is made through a high density DB-15 connector.

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SCHEMATICS

Circuit Description

1. RF AMPLIFIER

The receiver RF input circuit consists of seven high-Q helical resonators (H1-H7), two amplifier transistors (Q1, Q2) and associated components. The gain of this circuitry at the RF input frequency is nominally 20 dB. Superior intermodulation performance is obtained by passing input signals through two helical resonators (H1, H2) to reject out-of-band energy before amplification. Both amplifier transistors use high bias current for maximum overload capability and minimum distortion. Feedback is used to stabilize amplifier operation against temperature variations, and two sections of power supply decoupling per stage, further insure stable operation. The RF amplifier circuit output connects to the input of double balanced mixer SBL-1.

2. OSCILLATOR AND MULTIPLIER CHAIN

The fundamental frequency generated by oscillator Q3 is multiplied by stages Q4, Q5, Q6 and their associated components. The frequency of oscillator Q3 is controlled by crystals Y1 through Y4. In single frequency receivers, diode CR3 is replaced by a jumper selecting crystal Y3 as the frequency determining element. To further enhance stability, Y3 is enclosed in a proportional crystal oven. (This is an option in units built for amateur service.) In multi-frequency receivers, the frequency is determined by providing a ground at terminal E5, E8, E11, or E14 to select the associated crystal. The multiplication ratios of Q4 through Q6 depend upon the frequency range of the receivers as shown in the following table.

Frequency Range in MHz	Q4	Multiplier Q5	Q6
136-151	Doubler	Amplifier	Not Used
151-174	Tripler	Amplifier	Not Used
216-250	Doubler	Doubler	Not Used
420-512	Doubler	Doubler	Doubler

To minimize the number of possible images, all ACS receivers utilize high frequency crystals to reduce the total multiplication ratio needed to reach the required injection frequency. Double-tuned filters are used between all multiplier stages to further reduce image levels.

3. IF CIRCUITS AND DEMODULATION

The double balanced mixer output is fed to the 21.4 MHz IF amplifier. This circuit consists of transistors Q7 and Q8, eight crystal filter sections, and their associated components. Each amplifier stage output includes a tuned resonant circuit (L24, C60 and L27, C66 respectively) to reject signals at frequencies beyond the skirts of the ceramic filters. To ensure stability, generous feedback and decoupling is provided to minimize temperature and power supply effects.

Conversion from the 21.4 mhz. IF to the 455khz. IF, amplification of the 455KHz IF signal, limiting, and detection is done by integrated circuit U1 (squelch circuitry in U1 is not used). The second conversion oscillator circuitry (21.855 MHz.) is also contained in U1. The 455KHz four pole ceramic filter FL-9 (filter options are available) provides additional filtering. Seven amplifier stages contained in U1 provide excellent limiting before detection. FM detection is accomplished in the discriminator circuitry in U1 and is tuned by coil L28.

4. SQUELCH CIRCUIT

Wideband demodulated audio from U1 is rectified by diodes CR5 and CR6 to provide the voltage reference for squelch operation. This voltage is fed to a Schmitt trigger circuit consisting of transistors Q15 and Q16. Hysterisis in the circuit produces positive squelch action by requiring a change of about 6 dB in noise level before the receiver audio is switched from on to off. The Schmitt trigger can be controlled by an external CTCSS decoder to disable the receiver audio when no CTCSS signal is present. In applications where CTCSS operation is used, the CTCSS decoder connects to terminal E33 to control the Schmitt trigger operation.

Squelch operation is enhanced by automatically adjusting the squelch threshold in accordance with received signal level. Received signals at the low IF frequency are amplified by U2 and detected by CR3 and CR14. They are level shifted by U3A, and fed to fast / slow squelch transistor Q14. When a weak signal (less than 1 uV) is applied, transistor Q14 is turned on and pulls terminal E30 low to produce normal squelch action. When strong signals, greater than 1 u V, are received, Q14 is switched off. When is Q14 off, the reference voltage at the Schmitt trigger input is increased, thereby causing the squelch to be "tightened." "Tightening" the squelch causes faster operation in response to signal changes and virtually eliminates squelch tail noise. Thus, the receiver provides high squelch sensitivity to weak signals and noise free operation for strong signals.

Output from the Schmitt trigger gates the audio output of U1. When a received signal is present, audio from U1 passes to amplifier U3C. Audio output from U3C is used for line audio (terminal T10) and to drive U4 which provides a low impedance (8 ohm) local audio output for a speaker (T11).

5. METERING

Metering circuits are provided to monitor signal strength, discriminator centering and received signal peak deviation. The metering circuits are designed to drive 1mA, 220 ohm panel meters. Signal strength metering is

available at terminal T5 that is driven by DC amplifier transistor Q13. The signal strength meter indication is calibrated using potentiometer R66. Amplifier transistor Q11 drives terminal T7 to provide discriminator metering. Potentiometer R54 adjusts the discriminator meter which reads mid-scale when registering an on-frequency signal. The discriminator meter negative terminal should be returned to ground through a series connected diode. This is provided when the receiver is factory installed in a repeater or rack panel. The audio is amplified, rectified by CR9 and CR10 then level shifted by Q12 to drive peak deviation metering output terminal T6. Potentiometer R64 adjusts the meter setting.

Switched output (COS terminal T9) indicating the presence of a received signal is available from Q9 or Q10. Q10 provides a ground at terminal E16 when a received signal is present and open when no signal is present. An inverted output is available from Q9 by connecting a jumper from terminal E16 to E17 and taking the output from terminal E15.

• Installation

The following describes connections to ACS-R receivers furnished in modular form. Receivers factory installed in repeaters require no field installation.

NOTE: Terminals designated E (ex.-E12) are on the circuit board. Those with a T (ex.-T7) are on the outside of the box-see the wiring diagram on page 6.

1. **Connect to receiver terminal T12 (positive) and T4 (ground), a DC power source capable of supplying 12-15 volts at 250 ma., with less than 100 mv. of ripple.**
   If equipped with a proportional oven the requirements at turn on are 550 ma. for 45 seconds, then 310 ma. average.

   CAUTION: The receiver uses a negative ground and must be powered from a negative ground or floating power supply. DO NOT connect a positive ground power source to the receiver.

2. **To obtain a fixed-level audio output (line audio) connect to terminal T10 (signal) and T4 (ground). This output provides a level of approximately 400 mv. peak to peak at a source impedance of 1000 ohms. Shielded wire should be used for this connection.**

3. **To obtain power amplifier audio output for driving a loudspeaker, connect to terminal T11 (signal) and T4 (ground). This output provides a fixed level of approximately 3 volts peak to peak. An external 100 ohm potentiometer may be connected between this output and a speaker as shown in the wiring diagram to adjust the volume.**

4. **Connect a 50K ohm potentiometer to terminals T1, T2 and T3 as shown in the wiring diagram. This potentiometer is used for setting the receiver squelch threshold.**

5. To obtain a logic output indicating the presence of a received signal connect to terminal T9. T9 provides a ground when a received signal is present and an open when no received signal is present.

   If an inverted output is required, on the receiver board, connect a jumper from terminal E16 to terminal E17 and take the output from terminal E15. Terminal E15 provides an open when received signal is present and a ground when no received signal is present . (See the receiver schematic at the end of the manual.) These outputs will source or sink up to 100 MA at 15 volts.

6. If metering is to be used, connect 0-1 mA meters having internal resistances of 220 ohms to the following terminals: (Also see wiring diagram – page 6.)

Meter Indication	Meter + Terminal	Meter – Terminal
Signal Strength	T5	Ground
Peak Deviation	T6	Ground
Discriminator	T7	Ground through a series connected diode.

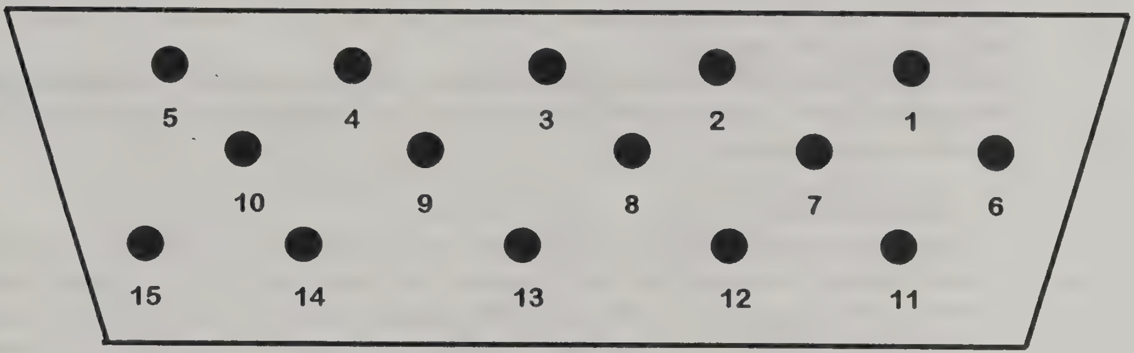
7. Adjust the signal strength meter by applying a strong (at least 2000 uv.) signal to the receiver input and set potentiometer R66 until the meter reads .9 mv. (on a 0-1 ma. meter scale).

   Set the discriminator meter by applying an on frequency signal to the receiver and adjusting potentiometer R54 for a center scale meter reading.

   Set the peak deviation meter reading by applying a signal having 5khz. deviation to the receiver and adjusting potentiometer R65 for a center scale reading. The meter indication is approximately proportional to deviation.

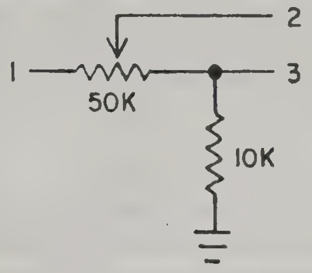
8. If CTCSS operation is used, connect terminals E18 (signal) and E19 (ground) to the CTCSS decoder input. Connect the CTCSS decoder output to terminal E33. The logic signal connected to terminal E33 should provide a ground when a CTCSS signal is detected by the decoder and an open when no CTCSS signal is detected. (See receiver schematic)

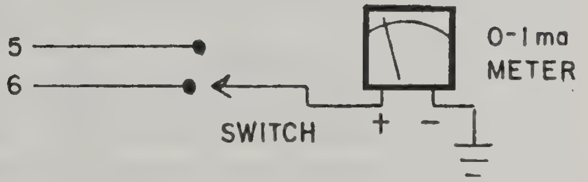
MR4 Receiver Connections

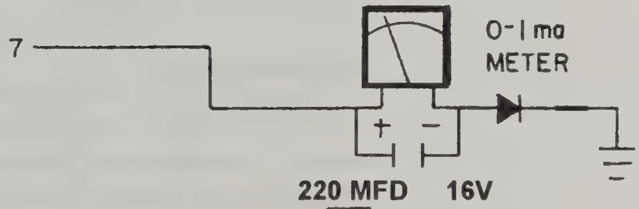


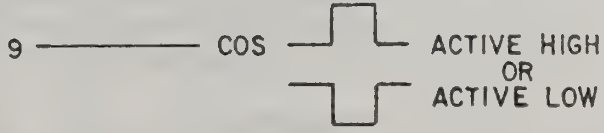
HIGH DENSITY DB-15 CONNECTOR
View looking at the outside of the box.

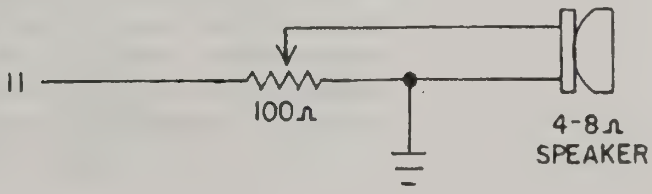
1. WH/RED:	SQ/HIGH
2. WH/OR :	SQ/WIPER
3. WH/GRAY:	SQ/LOW
4. NO CONNECTION	
5. VIOLET:	SIGNAL LEVEL
6. WH/BLK/O:	PEAK DEVIATION
7. WH/GREEN:	DISCRIMINATOR
8. NO CONNECTION	
9. ORANGE:	COS-Active high or low (factory set-active LOW)
10. GRAY/WH:	RECEIVER AUDIO 1K ohms impedance
11. WH/BLK/GRAY:	LOCAL AUDIO (8 ohms)
12. &13. BLUE:	B+ 12-15 VDC
14. NO CONNECTION	
15. GROUND	











- ## Alignment

All ACS-R receivers are factory aligned and generally require no initial alignment. If component replacement or a frequency change is necessary, perform only the adjustments pertaining to the circuit in which the component was replaced.

Alignment is critical to the proper operation of the receiver. An experienced technician and proper test equipment is required to align any high performance receiver.

1. RF AMPLIFIERS

   The RF section is aligned by applying a signal to the receiver input and connecting a selective RF monitor to terminal E1. Adjust helical resonator capacitors and coupling capacitors C4 and C15 to obtain a maximum indication on the monitor. Some interaction will occur between resonator H2 and capacitor C4 and between resonator H6 and capacitor C15, so these adjustments should be repeated as necessary until no further increase in gain is obtained.

   As adjustments are made, reduce the applied signal level to avoid saturating the amplifier transistors or the RF meter. When properly aligned, the RF section will exhibit a gain of approximately 20 dB. As a final check, retune for minimum noise with a signal input of less than .2 microvolt.

2. MULTIPLIER CHAIN

   The multiplier stages are aligned by connecting a selective RF monitor to test point TP4 and adjusting the tuning components (L15,16,17,18 and associated capacitors) for a maximum indication on the monitor. Once the stages are properly aligned, the injection voltage at TP4 should be greater than 300 mv.

3. IF AMPLIFIER

   The 21.4 mhz IF amplifier inductors L24 and L27 should not require adjustments in the field. The 455 khz IF frequency can be set by loosely coupling a frequency counter to U1 pin 1 and adjusting C107 to obtain a reading of 21.855 Mhz.

4. DISCRIMINATOR

   The discriminator is aligned by loosely coupling a 21.4 Mhz, 5 Khz deviated signal to the receiver IF and adjusting L28 for maximum output audio. If an oscilloscope is available, connect it to terminal T5 and adjust L28 for the maximum signal with least distortion. The positive peaks and the negative peaks should be equal. If not, the 21.855 Mhz oscillator may require adjustment.(C107)

5. FREQUENCY

   To set the receiver frequency, apply an on-frequency signal to the receiver input and adjust capacitor C24 to center the reading on the discriminator meter. In multi-frequency receivers, apply a ground to terminals E14, E11, E5, and E8 in turn to select the appropriate crystal and adjust capacitors C28, C26, C22, and C24, respectively.

MR4 RECEIVER PARTS LIST ONE REV A

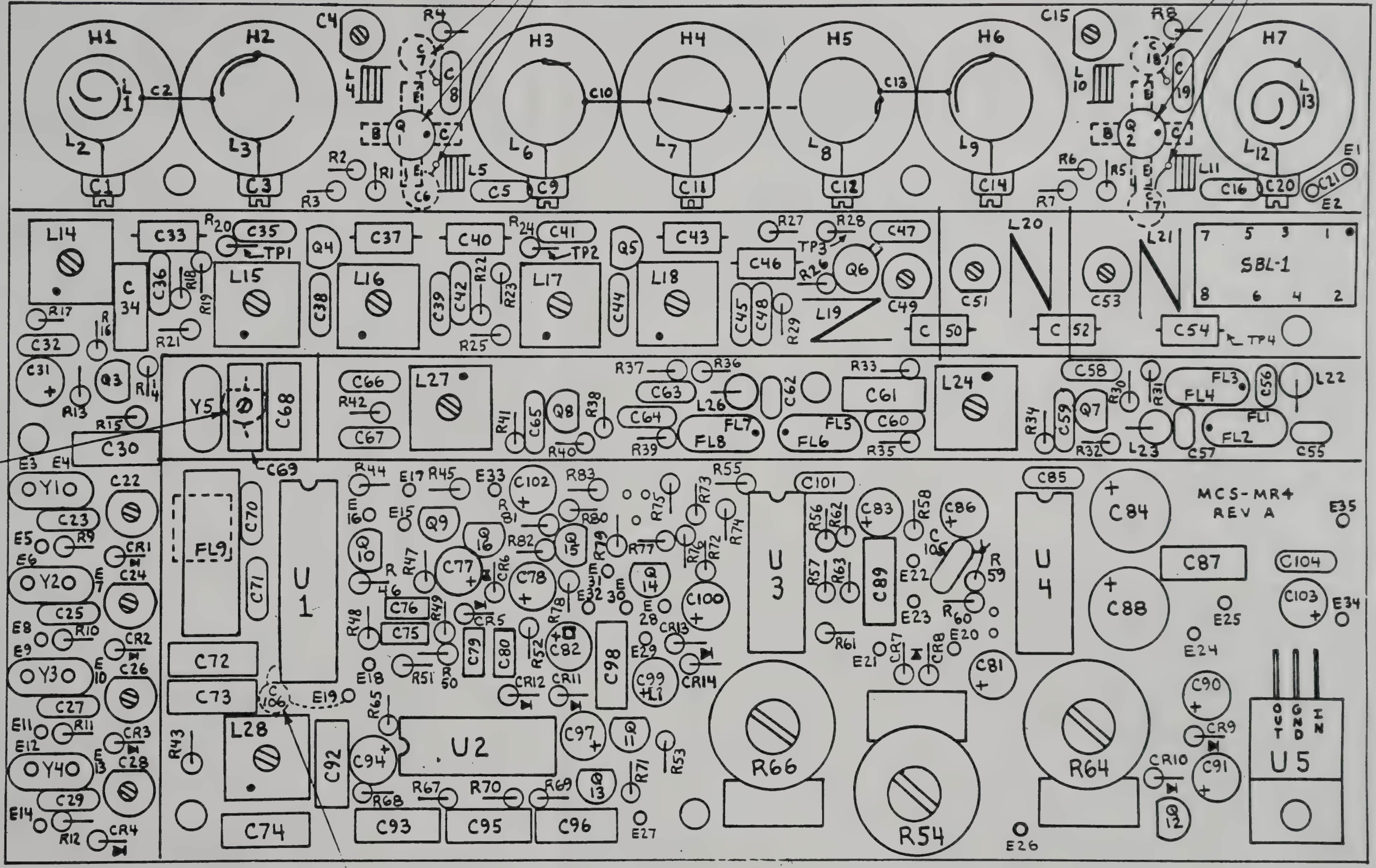
CAPACITORS		RESISTORS	
C1	Part of Helical Resonator	R1	1K
C2	Part of Helical Resonator	R2	1.8K
C3	Part of Helical Resonator	R3	220 ohm with F.Bead
C4	5-25 pf Trim Cap	R4	100 ohm
C5	.001 Disc	R5	1K
C6	.001 Disc	R6	1.8K
C7	.001 Disc	R7	220 ohm with F.Bead
C8	.001 Disc	R8	100 ohm
C9	Part of Helical Resonator	R9	10K
C10	Part of Helical Resonator	R10	10K
C11	Part of Helical Resonator	R11	10K
C12	Part of Helical Resonator	R12	10K
C13	Part of Helical Resonator	R13	15K
C14	Part of Helical Resonator	R14	3.3K
C15	5-25 pf Trim Cap	R15	220 ohm
C16	.001 Disc	R16	39 ohm with F.Bead
C17	.001 Disc	R17	1.5K
C18	.001 Disc	R18	6.8K
C19	.001 Disc	R19	1.8K
C20	Part of Helical Resonator	R20	220 ohm
C21	.001 Disc	R21	47 ohm with F.Bead
C22	5-25 pf Trim Cap	R22	6.8K
C23	.001 Disc	R23	1.8K
C24	5-25 pf Trim Cap	R24	220 ohm
C25	.001 Disc	R25	47 ohm with F.Bead
C26	5-25 pf Trim Cap	R26	6.8K
C27	.001 Disc	R27	1.8K
C28	5-25 pf Trim Cap	R28	220 ohm
C29	.001 Disc	R29	47 ohm with F.Bead
C30	100 pf silver Mica	R30	1K
C31	4.7 Mfd 126v.	R31	2.7K
C32	.001 Disc	R32	1K
C33	F.S.	R33	47 ohm with F.Bead
	8 pf SM (135 – 174 MHz)	R34	75 ohm
	8 pf SM (420 – 512 MHz)	R35	2K
	12 pf SM (216 – 250 MHz)	R36	2K
C34	F.S.	R37	47 ohm with F.Bead
	56 pf NPO (135 – 151 MHz)	R38	1K
	47 pf NPO (151 – 158 MHz)	R39	2.7K
	36 pf NPO (158 – 174 MHz)	R40	1K
	39 pf NPO (215 – 250 MHz)	R41	75 ohm
	20 pf NPO (470 – 512 MHz)	R42	2.2K
C35	.001 Disc	R43	100K

C36	.001 Disc
C37	1 pf NPO
C38	F.S. 10 pf NPO (135 –151 MHz) 12 pf NPO (151 –158 MHz) 10 pf NPO (158 – 250 MHz) 15 pf NPO (420 –512 MHz)
C39	F.S. 10 pf NPO (135 –151 MHz) 10 pf NPO (151 –158 MHz) 8 pf NPO (158 –174 MHz) 12 pf NPO (215 – 512 MHz)
C40	1 pf (5 pf 220 MHz only)
C41	.001 Disc
C42	.01 Disc
C43	NPO
C44	22 pf
C45	6.8 NPO Disc
C46	1 pf NPO
C47	.001 Disc
C48	.01 Disc
C49	3 – 15 pf Trim Cap
C50	1 pf
C51	3 – 15 pf Trim Cap
C52	3 – 15 pf Trim Cap
C53	3 – 15 pf Trim Cap
C54	1 pf
C55	33 pf NPO
C56	10 pf NPO
C57	27 pf NPO
C58	.01 Disc
C59	.01 Disc
C60	33 pf NPO
C61	.01 Disc
C62	10 pf NPO
C63	.01 Disc
C64	.01 Disc
C65	.001 Disc
C66	33 pf NPO
C67	.01 Disc
C68	100 pf S.M.
C69	17 pf S.M.
C70	.01 Disc
C71	100 pf NPO
C72	.1 Disc

R44	4.7K
R45	1K
R46	47K
R47	4.7K
R48	390K
R49	10K
R50	20K
R51	7.5K
R52	4.7K
R53	390 ohm
R54	10K pot
R55	20K
R56	47K
R57	20K
R58	1K
R59	200K
R60	39 K.F.S.
R61	470K
R62	1 Meg
R63	47-K
R64	
R65	1 Meg
R66	
R67	
R68	
R69	
R70	
R71	
R72	
R73	
R74	1 Meg
R75	
R76	
R77	
R78	
R79	
R80	
R81	
R82	
R83	
R84	
R85	

C36	.001 Disc	R44	4.7K
C37	1 pf NPO	R45	1K
C38	F.S.	R46	47K
	10 pf NPO (135 –151 MHz)	R47	4.7K
	12 pf NPO (151 –158 MHz)	R48	390K
	10 pf NPO (158 – 250 MHz)	R49	10K
	15 pf NPO (420 –512 MHz)	R50	20K
C39	F.S.	R51	7.5K
	10 pf NPO (135 –151 MHz)	R52	4.7K
	10 pf NPO (151 –158 MHz)	R53	390 ohm
	8 pf NPO (158 –174 MHz)	R54	10K pot
	12 pf NPO (215 – 512 MHz)	R55	20K
C40	1 pf (5 pf 220 MHz only)	R56	47K
C41	.001 Disc	R57	20K
C42	.01 Disc	R58	1K
C43	NPO	R59	200K
C44	22 pf	R60	39 K.F.S.
C45	6.8 NPO Disc	R61	470K
C46	1 pf NPO	R62	1 Meg
C47	.001 Disc	R63	47-K
C48	.01 Disc	R64	
C49	3 – 15 pf Trim Cap	R65	1 Meg
C50	1 pf	R66	
C51	3 – 15 pf Trim Cap	R67	
C52	3 – 15 pf Trim Cap	R68	
C53	3 – 15 pf Trim Cap	R69	
C54	1 pf	R70	
C55	33 pf NPO	R71	
C56	10 pf NPO	R72	
C57	27 pf NPO	R73	
C58	.01 Disc	R74	1 Meg
C59	.01 Disc	R75	
C60	33 pf NPO	R76	
C61	.01 Disc	R77	
C62	10 pf NPO	R78	
C63	.01 Disc	R79	
C64	.01 Disc	R80	
C65	.001 Disc	R81	
C66	33 pf NPO	R82	
C67	.01 Disc	R83	
C68	100 pf S.M.	R84	
C69	17 pf S.M.	R85	
C70	.01 Disc		
C71	100 pf NPO		
C72	.1 Disc		

REV	DESCRIPTION	APP	DATE
A2	REVISED		10/31/83
A3	REVISED & RELEASED	WRD	11/3/83



INSTALL FARSIDE
Q1, C6, C7

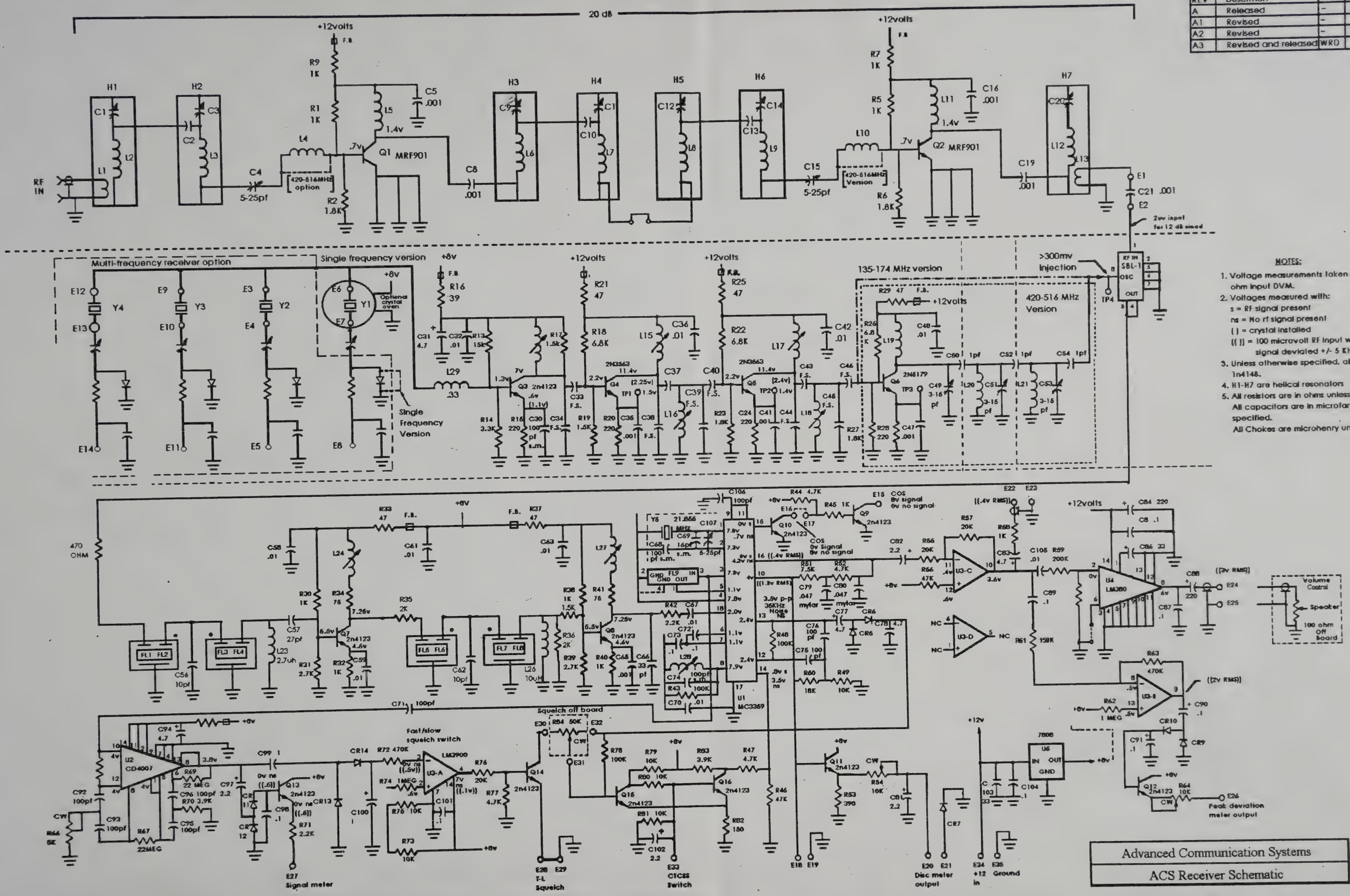
INSTALL FARSIDE
Q2, C17, C18

INSTALL FARSIDE
C107

INSTALL FARSIDE
C106

MICRO CONTROL SPECIALTIES
23 ELM PARK GROVELAND, MA. 01834
2 x 1
8 23 83
WILLIAM R. DEWHIRST
DRAGONWYCK
ASSEMBLY DRAWING
RECEIVER P.C. BOARD
REV A3. MCS - MRR

REV	Descrition	App	Date
A	Released	–	8/1/83
A1	Revised	–	10/30/83
A2	Revised	–	11/02/83
A3	Revised and released	WRD	11/09/83



NOTES:

1. Voltage measurements taken on a 15 MEG ohm input DVM.
2. Voltages measured with:
   s = RF signal present
   ns = No rf signal present
   ( ) = crystal installed
   (( )) = 100 microvolt RF input with a 1 KHz signal deviated +/- 5 KHz.
3. Unless otherwise specified, all diodes are 1n4148.
4. H1-H7 are helical resonators
5. All resistors are in ohms unless specified.
   All capacitors are in microfarads unless specified.
   All Chokes are microhenry unless specified.

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ACS Receiver Schematic

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Thank you

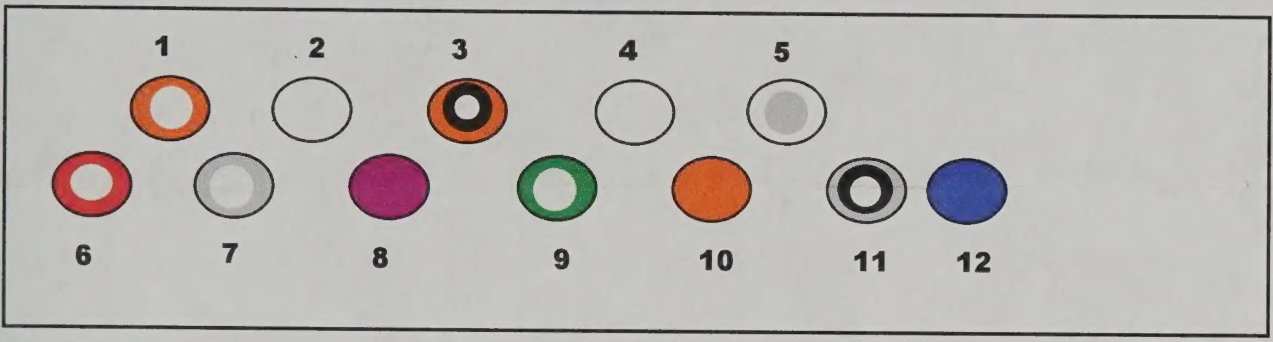
ACS wants to let you know how much we value your business and the confidence you have placed in our products. Should you have questions or problems feel free to contact us. We will always do everything possible to continue to earn your trust and goodwill.

It is a pleasure to do business with you.

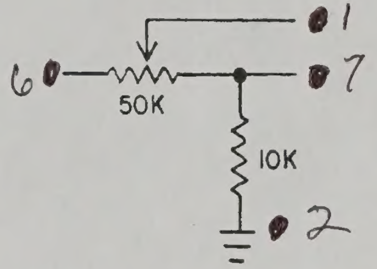
Gary J. Welch
W1FCK

GARY — I INCLUDED THIS JUST IN CASE
YOU DON'T HAVE AN OLD RECIVER MANUAL
FOR CONNECTING THE FRONT PANEL.

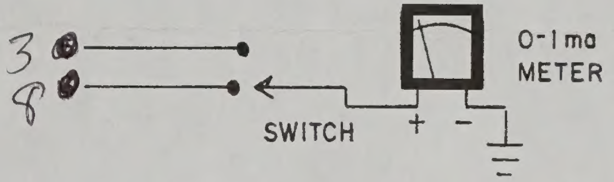
MR4 RECEIVER



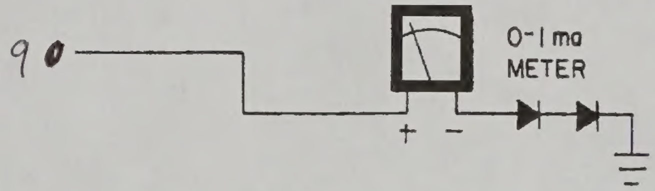
1. WH/OR – SQWIPER
2. GND (when provided)
3. WH/Blk/OR Peak Deviation
4. NO CONNECTION



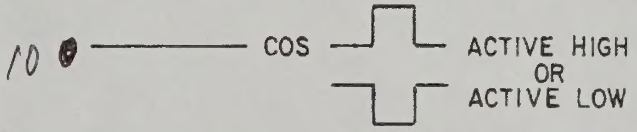
5. Grey/WH shielded RCVR Audio
6. WH/RED SQUELCH High



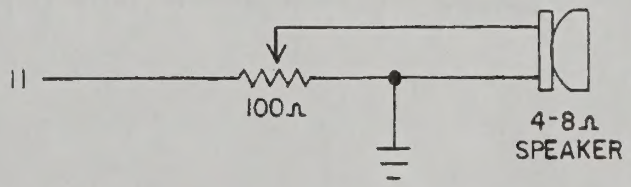
7. WH/GRAY SQUELCH Low
8. Violet – Signal Level
9. WH/GRN – Discriminator Meter



10. Orange – COS
11. WH/Blk/Gray – Local Audio 8 ohms



12. Blue – B+12v



COS active HIGH or LOW (factory set active ~~high~~)
LOW

Oxford
ESSELTE
10%